Biyani's Think Tank

Concept based notes

Fundamentals of Bioinformatics and Nanotechnology

[B.Sc. Biotech Part-III]

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Preface

I am glad to present this book, especially designed to serve the needs of the students. The book has been written keeping in mind the general weakness in understanding the fundamental concepts of the topics. The book is self-explanatory and adopts the "Teach Yourself" style. It is based on question-answer pattern. The language of book is quite easy and understandable based on scientific approach.

Any further improvement in the contents of the book by making corrections, omission and inclusion is keen to be achieved based on suggestions from the readers for which the author shall be obliged.

I acknowledge special thanks to Mr. Rajeev Biyani, *Chairman* & Dr. Sanjay Biyani, *Director* (*Acad.*) Biyani Group of Colleges, who are the backbones and main concept provider and also have been constant source of motivation throughout this Endeavour. They played an active role in coordinating the various stages of this Endeavour and spearheaded the publishing work.

I look forward to receiving valuable suggestions from professors of various educational institutions, other faculty members and students for improvement of the quality of the book. The reader may feel free to send in their comments and suggestions to the under mentioned address.

Note: **A feedback form is enclosed along with think tank. Kindly fill the feedback form and submit it at the time of submitting to books of library, else NOC from Library will not be given.**

Pragya Dhakar

Syllabus

B.Sc./M.Sc.

Fundamentals of Bioinformatics and Nanotechnology

Note : Question No. 1 shall consist of questions requiring short answers and shall cover entire paper. The paper is divided into four sections. Students are required to attempt five questions in all, selecting not more than one question from each section. All questions carry equal marks.

Section-A

1. Introduction to Bioinformatics
2. Aspects of Bioinformatics
3. Role of Bioinformatics in Biotechnology
4. Applications of Bioinformatics

Section-B

5. Introduction to Nanotechnology
6. Carbon Nanostructures
7. Properties of Nanoparticles

Section-C

8. Biological Materials in Nanotechnology
9. Nanomachines and Devices
10. Advanced Nanotechnology

Section-D

11. Medical Nanotechnology
12. Bio Nanotechnology
13. Nanotechnology and Society

FUNDAMENTALS OF BIOINFORMATICS AND NANOTECHNOLOGY

Q.1. What is Nanotechnology?

Ans. Nanotechnology is a multidisciplinary area of applied sciences and engineering that deals with the design and manufacture of extremely small components and systems.

Q.2. How did Nanotechnology evolve?

Ans. "Richard Feynman" a brilliant Nobel laureate physicist in a lecture on 29 December 1959 described the term Nanotechnology as "a process by which the ability to manipulate individual atoms & molecules might be developed, using one set of precise tools to build and operate another proportionally smaller set." He didn't use the term Nanotechnology. Nanotechnology reached greater public awareness in 1986 by "Dr. K. Eric. Drexler"

Q.3. Why is Nanotechnology called as General Purpose Technology?

Ans. Nanotechnology is often referred to as general purpose technology because in its advanced form it will have significant impact on almost all industries and all areas of society.

Q.4. Write the uses of Nanotechnology?

Ans. The uses of Nanotechnology are:

(i) Nanoparticles, Nanopowers and Nanotubes play a signify cant role in Industry, Environmental, Remediation, Medicine science and household.

(ii) Rear earth Nanoparticles and rare earth oxide powders are used as enhanced fiber optic amplification (EDFA) to remove phosphate in blood of patients with Hyperphosphatemia.

(iii) Iron Nanoparticles, Iron oxide nanopowders, cobalt Nanoparticles called Magnetic Nanoparticles are used for treatment of cancer, magnetic storage and magnetic resonance imaging(MRI)

(iv) Carbon Nanotubes are single walled, double walled and multiwalled black nano scale cylindrical tubes of graphitic carbon. They are stiffest and strongest fibers which have unique electrical properties. They are used in flat screen displays, scanning probe microscopes, sensing devices, body armors, tear resistant cloth fiber, and lighter sport equipments.

(v) Used in solving world energy crisis they are used as solid oxide fuel cells e.g.: Lanthanum Nanoparticles, cerium NO strontium carbonate Nanoparticles, manganese Nanoparticles, Manganese Oxide Nanoparticles, nickel oxide Nanoparticles silicon particles are used in solar energy cells

(vi) Used in making transparent sunscreen e.g.: TnO, Silver Nanoparticles

(vii) Also used as antimicrobial, antibacterial , antibiotic and antifungal agents when used in coatings, fibers, polymers, plastic, soaps and textiles

(viii) Used as super conductors, electric conductors, semiconductors in high speed computing, telecommunication and space travel e.g. Carbon Nano Tubes, Si02

(ix) Used in plastic nanocomposities for strong, lighter and rust proof car components e.g. Toyota is using Nanoparticles in making bumper which are lighter, resistant to denting and scratching. Carbide Nanoparticles, silicon carbide Nanoparticles, titanium carbide Nanoparticles

(x) Used as catalyst in chemical synthesis, chemical treatment and chemical cracking as they have extremely his surface area. E.g. Platinum Nanoparticles, Palladium Nanoparticles, gold Nanoparticles, Molybdenum Nanoparticles.

(xi) Used in manufacture of artificial bone composites e.g. calcium phosphate, nanocrystals as they have strength.

(xii) In dental imaging e.g. tungsten oxide Nanoparticles as they are radiopaque for high quality X-ray resolution.

(xiii) Used to kill cancer cells & in MRI medical imaging e.g. magnetic Nanoparticles (xiv) Fluorescent Nanoparticles are used by biologist to stain and label cellular components.

(xv) Used as dehaloginating agents e.g. Nickel Nano crystals used to remove trichloroethylene(TCE) which is a common ground water contaminant

Q.5. Write a short note on future aspects of Nanotechnology?

Ans. Nanotechnology is expected to have an impact on nearly every industry.

(i) Research community is conducting experiments on production of Nanomaterials, nanoelectronics and bionanotechnology.

(ii) Application in production of Nanocomposites, antibacterial Nanoparticles and nanostructured catalyst in next 1-5 years.

(iii) In 5-15 yrs nanodevices will be used in medical treatments and diagnostics, sensors and faster computers.

(iv) Will be used in manipulating single atom/ molecules.

Q.6. Define self assembly and write its characteristics?

Ans. Self assembly is the fundamental principle which generates structural organization on all scales from molecules.

The characteristics of self assembly are:

(i) Can occur spontaneously in nature

(ii) It results in increase in internal organization of the system.

(iii) Have superior handling biocompatibility & functionality

(iv) It is a manufacturing method used to construct things at the micro scale.

(v) The final/desired structure is encoded in the shape and properties of molecules.

(vi) The synthesis involves a chemical process called convergent synthesis.

Q.7. What is Top down fabrication technique?

Ans. In top down fabrication a bulk material is reduced in size to nanoscale pattern. These seek to create smaller devices by using larger to direct their assembly.

Q.8. Define Electron beam Lithography and give its advantages?

Ans. It is a specialized technique for create integrated circuits at the nanoscale. Electron beam Lithography uses the beam of electrons to generate patterns on

a surface. Advantages of Electron beam Lithography are:

(i) It is one of the ways to beat the diffraction limit of light and make features in the submicrometer regime.

(ii) This form of lithography has found wide usage in research, but has yet to become a standard technique in industry. The main reason for this is speed.

Q.9. Write a short note on Nanoimprint Lithography?

Ans. One of the cheapest nanolithography techniques available for laboratories is Nanoimprint, and the resolution reached can be as low as 10 nm.

The principle of this tenichque is the embossing of a patterned mold is the heated resist. A stamp with suitable features sizes, the adequate polymer material to be printed and equipment for printing with adequate temperature and pressure control are the three pillars of Nanoimprint lithography. The first step in nanoimprinting is building a silicon relief mold using direct - write e- beam equipment. That is slow process where in each features is defined by rastering an electron beam across the wafer. But once the imprint mold has beam defined, it can be used to stamp out features with the small parallel speed of the mask- based exposure process.

Successful development of NIL can remove the main obstacle, cost, to Nanostructure commercialization and will make nanostructures easily accessible for industrial application.

Q.10. What is an Electron Microscope? Name five types of electron microscopes?

Ans. The electron microscope is a type of microscope that uses electron to create an image of the target. It has much higher magnification or resolving power than a normal light microscope. Different types of electron microscope are:

(i) Transmission Electron Microscope (TEM)

(ii) Scanning Electron Microscope (SEM)

(iii) Scanning Transmission Electron Microscope (STEM)

(iv) Reflection Electron Microscope (REM)

(v) Scanning Tunneling Microscope (STM)

Q.11. Give the drawbacks and the fields of applications of Transmission Electron Microscope?

Ans. The drawbacks of Transmission Electron Microscope are:

1. Require extensive sample preparation
2. Time consuming
3. The structure of sample may also be changed during the process
4. The field of view is small
5. Sample may be damaged due to electron beam

The two fields where TEM is being used are

1. For carrying out reconstruction of biological materials.
2. In metal science/ metallurgy of the specimens

Q.12. Give the different methods of sample preparation for an Electron Microscope?

Ans. Samples viewed under an electron microscope may be treated in many ways:

1. Cryofixation
2. Fixation
3. Dehydration
4. Embedding
5. Sectioning
6. Staining
7. Freeze-fracture
8. Ion Beam Milling
9. Conductive coating
10. Evaporation

Q.13. What is an Atomic Force Microscope? In detail explain its working?

Ans. The atomic force microscope is a very high resolution type of scanning probe microscope. The AFM was invented by Binning, Quate and Wang in 1986. It is one of the foremost tool for imaging, measuring and manipulating matter at nanoscale. A traditional AFM consist of the following parts:

1. Scanner

2. Sample surface
3. Cantilever and tip
4. Laser light
5. Photodiodes
6. Detector and feedback electronics

Working of AFM:

1. The AFM consists of a microscale cantilever with a sharp tip at its end that is used to scan the specimen surface. 2. When the tip is brought close to the sample surface, forces between the tip and the sample lead to a deflection of the cantilever.
3. The deflection is measured using a laser spot reflected from the top of the cantilever into an array of photodiodes.
4. The deflection is then detected by a detector.

Q.14. What are the advantages of Atomic Force Microscope over Scanning Electron Microscope?

Ans. The Atomic Force Microscope (AFM) has several advantages over the Scanning Electron Microscope (SEM) as:

1. AFM provides a 3D surface profile whereas SEM provides a 2D image of an object.
2. Samples viewed by AFM don't require any special treatments that could irreversibly change or damage the sample.
3. A SEM requires a vacuum environment for proper operation but AFM can work perfectly in air or liquid environment and thus living organisms can also be studied.

Q.15. What are Nanomaterials?

Ans. Nanomaterials or Nanocrystalline materials are materials possessing grain sizes on the order of a billionth of a meter.

Q.16. What are the properties of Nanomaterials?

Ans. The properties of Nanomaterials are:

(i) They are exceptionally strong
(ii) They are hard
(iii) They are ductile at high temperatures

(iv) They are wear resistant

(v) They are erosion-resistant

(vi) They are corrosion-resistant

(vii) They are chemically very active**Q.17. Name five widely used methods for production of Nanomaterials?**

Ans. The five widely used methods to produce Nanomaterials are:

(i) Sol-gel synthesis

(ii) Inert gas condensation

(iii) Mechanical alloying

(iv) High energy ball milling

(v) Plasma synthesis

(vi) Electrodeposition

Q.18. Mention the applications of Nanomaterials ?

Ans. The applications of Nanomaterials are :

(i) Next generation computer chips

(ii) Kinetic energy penetrators with enhanced lethality

(iii) Better insulation materials

(iv) Phosphors for high-definition TV

(v) Low cost flat-panel displays

(vi) Tougher and harder cutting tools

(vii) Elimination of pollutants

(viii) High-energy density batteries

(ix) High-power magnets

(x) High-sensitivity sensors

(xi) Automobiles with greater fuel efficiency

(xii) Aerospace components with enhanced performance characteristics

(xiii) Better and future weapons platforms

(xiv) Longer-lasting satellites

(xv) Longer-lasting medical implants

(xvi) Ductile ceramics

(xvii) Large electrochromic display devices

Q.19. Explain Fullerenes?

Ans. Fullerenes are closed spherical carbon structures. Kroto in 1985 first observed fullerenes. Fullerenes consist of C70, C76, C84, C240, C540 and so on. The fullerenes, being closed structures with zero genus, differ by their shape and symmetry. The fullerenes are potential nano-capsules. A common method used to produce fullerenes is to send a large current between two nearby graphite electrodes in an inert atmosphere. The resulting carbon plasma are between the electrodes cools into sooty residue from which many fullerenes can be isolated. Fullerenes are:

1. Harder than diamond
2. Bind to specific antibiotics
3. Can target cancer cells
4. Sparingly soluble in toluene and carbon disulfide.
5. Have a deep purple color.
6. Dissolved in common solvents at room temperature.
7. Exist in two optical forms.

Q.20. What are Carbon Nanotubes and how are they produced?

Ans. Carbon nanotubes are the tubes made from grapheme plain, with one or more than one layers. Ijima first discovered carbon nanotubes. Carbon nanotubes are also called as a tube of graphite. Carbon nanotubes are nanoscopic structure made of carbon atoms in the shape of a hollow cylinder. The cylinders are typically closed at their ends by semi-fullerenes like structures. The carbon nanotubes are produced using four main methods:

1. Arc discharge of graphite electrodes in inert atmospheres
2. Pyrolysis of hydrocarbons over catalyst.
3. Laser vaporization of graphite targets.
4. Electrolysis of graphite electrodes in the molten salts.
5. Methane burning. **Q.21. Mention the properties and industrial applications of Carbon Nanotubes?**

Ans. The properties of carbon nanotubes are:

1. Carbon nanotubes are metallic or semi conducting
2. Carbon nanotubes possess great strength

3. Carbon nanotubes are stable at high temperatures
4. Carbon nanotubes are stable in air environment
5. Carbon nanotubes are very strong against strong acids and high temperature

6. Carbon nanotubes have attractive emission characteristics

7. Carbon nanotubes have high electrical and thermal conductivity

The industrial applications of carbon nanotubes are:

1. Carbon nanotubes are molecular building blocks of nanotechnology.
2. Carbon nanotubes improve the performance of
   - Tiny sensors
   - Electronic and optical; devices
   - Catalysts
   - Batteries
   - Fuel cells
   - Solar cells
   - Drug delivery vehicles
3. Lithium batteries containing carbon Nanowires have double energy capacity.
4. Carbon transistors will soon replace silicon transistors.
5. Carbon nanotubes are used in making stronger and lighter tennis rackets.
6. Carbon nanotubes are used in making bullet proof jackets.
7. Carbon nanotubes are used to make plastic fire retardant.
8. Carbon nanotubes are efficient alternative to fossil fuels as th9. Wires made up of carbon nanotubes conduct more electricity than copper wires.
10. Carbon nanotubes are being used in space lift due to their good strength and light weight.
11. Carbon nanotubes are used for separation and storage of biological active materials and gases.

Q.22. What are Nanowires? Name five types of Nanowires?

Ans. Nanowires is a wire of dimensions of the order of a nanometer. They are also called as Quantum wires. Different types of nanowires are:

1. Metallic Nanowires e.g. Ni, Pt, Au.

2. Semi conducting Nanowires e.g. Si, InP, GaN.
3. Insulating Nanowires e.g. SiO_2, TiO_2.
4. Molecular Nanowires
   - Organic e.g. DNA
   - Inorganic e.g. $Mo_6S_{9-x}I_x$, $Li_2Mo_6Se_6$.

Q.23. Explain the structure of Nanowires?

Ans. The nanowires show peculiar shapes. Sometimes they can show noncrystalline order e.g. pentagonal symmetry or a helicoidal (spiral) shape. The lack of crystalline order is because nanowire is periodic only in one dimension. Hence it can assume any order in the other direction. Nanowires are observed spontaneously in nature. Nanowires can be either suspended, deposited or synthesized from the elements.

Q.24. Give the uses and applications of Nanowires?

Ans. The uses of nanowires are:

1. To create p-type and n-type semiconductors
2. To create active electronic devices9. Wires made up of carbon nanotubes conduct more electricity than copper wires.
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Q.24. Give the uses and applications of Nanowires?

Ans. The uses of nanowires are:

1. To create p-type and n-type semiconductors
2. To create active electronic devices
3. To build logic gates e.g. AND, OR, NOT, etc. 4. In digital computing

The applications of nanowires are:

1. as additives in advanced composites
2. as field emittors
3. as leads for biomolecular nanosensors
4. for metallic interconnects in nanoscale quantum devices

Q.25. What are Quantum Dots?

Ans. When two Nanowires acting as photon waveguides cross each the juncture acts as a Quantum Dot.

Q.26. What is the difference between Nanocones and Nanohorns?

Ans. Carbon Nanocones are made up of hexagonal plane with a different number of pentagonal defects. Carbon Nanohorns is a special class of Nanocones with exact five defects on the tip.

Q.27. Give three potential risks of Nanomaterials?

Ans. Potential risks of nanotechnology are:

1. The risk to health and environment
2. The risk by molecular manufacturing

3. Societal risks

Q.28. Mention the lab safety guidelines for handling Nanomaterials?

Ans. The lab safety guidelines for handling Nanomaterials are:

1. Avoid skin contact with nanoparticles.
2. Wear appropriate respiratory protective.
3. Use fume exhaust hoods to expel fumes.
4. Dispose off nanoparticles considering waste guidelines.
5. Vacuum cleaners used to clean nanoparticles should be properly tested.
6. Potential contamination in instruments should be evaluated.
7. Lab equipments and exhaust systems should be evaluated and repaired time to time.
8. Potential fire and explosive hazards should be kept in mind.
9. Use good general lab safety practices for hygiene plan.
10. Wear gloves, lab coats, safety glasses, face shields, closed toed shoes are needed.

Q.29. Define the term Biomimicry?

Ans. Biomimicry is a process of copying plants i.e. photosynthesis mechanism.

Q.30. Define Nanocomposites?

Ans. Nanocomposites are a large variety of systems such as 1-D, 2-D, 3-D and amorphous materials, made of distinctly dissimilar components and mixed at the nanometer scale.

Q.31. How can Nanocomposites be designed?

Ans. Nanocomposites can be designed by the following synthetic routes:

1. In situ intercalative polymerization (ISIP)
2. Monolayer intercalation followed by topotactic intralamellar solid state polymerization
3. Direct percipitative encapsulation

Q.32. Describe the applications of Nanocomposites?

Ans. The applications of nanocomposities are:

1. Particle loading
2. Mechanical property improvement due to nanoparticle additions
3. Gas barriers
4. Oxygen barriers5. Food packaging
6. Fuel tanks
7. Films
8. Environment protection
9. Flammability reduction

Q.33. What are Bio-nano Devices ?

Ans. Biomolecular nano devices, Biomolecular structures with mechanical functions, are ubiquitous in nature and are fundamental to the process and function of life. E.g. Membrane proteins and molecular machines.

Q.34. What is Nanobiology?

Ans. Nanobiology is the synergy of surface science and molecular biology. It symbolizes a path breaking evolution in biology. It is capable of unveiling many fundamental secrets of life forms.

Q.35. Give the four major aspects of Nanobiology?

Ans. The four major aspects of Nanobiology are:

1. Interaction between biomolecules and nanoparticle surfaces
2. Biological imaging using nanoparticles
3. Analytical applications of Nanobiology
4. Medical diagnosis and targeted drug delivery

Q.36. Name different types of inorganic materials used for the synthesis assemblies?

Ans. Different types of inorganic materials are:

1. Nobel metal materials
2. Semiconductor nanocrystals (Quantum dots)
3. Magnetic nanoparticles

Q.37. What are the properties of Quantum Dots?

Ans. the properties of Quantum dots are:

1. Narrow spectral line width
2. High luminescence
3. Continuous absorption profile
4. Stability against photo bleaching
5. Ideal immuno-labels for fluorescent imaging

Q.38. Mention the fields where magnetic nanoparticles can be used?

Ans. Magnetic nanoparticles have applications in the following spheres:

1. Proteomics
2. Molecular cell biology
3. Medical science
4. Analytical biochemistry
5. Clinical diagnostics
6. Microbiology
7. Immunology
8. Biotechnology
9. Targeted drug delivery

Q.39. Give the applications of Nanotechnology in Biology?

Ans. the applications of nano in biology are:

- Biological imaging using semiconductors nanocrystals
- Immuno fluorescent biomarker imaging
- Immunogold labeling
- Diagnostic applications of immuno-targeted nanoparticles
- Targeted drug delivery using nanoparticles

Q.40. What is Bioinformatics?

Ans. Bioinformatics is the application of information technology to the field of molecular biology.Bioinformatics entails the creation and advancement of databases, algorithms, computational and statistical techniques, and theory to solve formal and practical problems arising from the management and

analysis of biological data. Bioinformatics is that branch of life science,which deals with the study of application of information technology to the field of molecular biology. Bioinformatics is the use of IT in biotechnology for the data storage, data warehousing and analyzing the DNA sequences.

Q.41. Give the major research areas of Bioinformatics?

Ans. The major research areas of bioinformatics include :

1. Sequence analysis
2. Genome annotation
3. Computational evolutionary biology
4. Measuring biodiversity
5. Analysis of gene expression
6. Analysis of regulation
7. Analysis of protein expression
8. Analysis of mutations in cancer
9. Prediction of protein structure
10. Comparative genomics
11. Modeling biological systems
12. High-throughput image analysis
13. Protein-protein docking
14. Software and tools
15. Web services in bioinformatics

Q.42. What is a biological database?

Ans. A biological database is a large, organized body of persistent data, usually associated with computerized software designed to update, query, and retrieve components of the data stored within the system. A simple database might be a single file containing many records, each of which includes the same set of information.

Q.43. Define Gene Bank?

Ans. Gene Bank (Genetic Sequence Databank) is one of the fastest growing repositories of known genetic sequences. It has a flat file structure that is an ASCII text file, readable by both humans and computers. In addition to

sequence data, GenBank files contain information like accession numbers and gene names, phylogenetic classification and references to published literature.

Q.44. Describe EMBL?

Ans. The EMBL Nucleotide Sequence Database is a comprehensive database of DNA and RNA sequences collected from the scientific literature and patent applications and directly submitted from researchers and sequencing groups. Data collection is done in collaboration with GenBank (USA) and the DNA Database of Japan (DDBJ). The database currently doubles in size every 18 months.

Q.45. What is SWISS prot?

Ans. Swiss Port is a protein sequence database that provides a high level of integration with other databases and also has a very low level of redundancy (means less identical sequences are present in the database).

Q.46. What is GDB?

Ans. The GDB Human Genome Data Base supports biomedical research, clinical medicine, and professional and scientific education by providing for the storage and dissemination of data about genes and other DNA markers, map location, genetic disease and locus information, and bibliographic information. **Q.47. Explain PIR-PSD?**

Ans. PIR (Protein Information Resource) produces and distributes the PIR-International Protein Sequence Database (PSD). It is the most comprehensive and expertly annotated protein sequence database. The PIR serves the scientific community through on-line access, distributing magnetic tapes, and performing off-line sequence identification services for researchers.

Protein sequence databases are classified as primary, secondary and composite depending upon the content stored in them. PIR and SwissProt are primary databases that contain protein sequences as 'raw' data. Secondary databases (like Prosite) contain the information derived from protein sequences. Primary databases are combined and filtered to form non-redundant composite database.

Q.48. Write a short note of origin of Bioinformatics?

Ans. There are different views of origin of Bioinformatics. "The term bioinformatics is used to encompass almost all computer applications in biological sciences, but was originally coined in the mid-1980s for the analysis of biological sequence data." :"The term "bioinformatics" is a relatively recent invention, not appearing in the literature until 1991 and then only in the context of the emergence of electronic publishing. The first bioinformatics/biological databases were constructed a few years after the first protein sequences began to become available. The first protein sequence reported was that of bovine insulin in 1956, consisting of 51 residues. Nearly a decade later, the first nucleic acid sequence was reported, that of yeast alanine tRNA with 77 bases. Just a year later, Dayhoff gathered all the available sequence data to create the first bioinformatics database. The Protein Data Bank followed in 1972 with a collection of ten X-ray crystallographic protein structures, and the SWISS PROT protein sequence database began in 1987. A huge variety of divergent data resources of different types and sizes are now available either in the public domain or more recently from commercial third parties

Q.49. What are major categories of Bioinformatics Tools?

Ans. The major categories of Bioinformatics Tools are:

1. Homology and Similarity Tools
2. Protein Function Analysis
3. Structural Analysis
4. Sequence Analysis

Q.50. Name some Bioinformatics Tools?

Ans. Some Bioinformatics Tools are:

1. BLAST - Basic Local Alignment Search Tool
2. FASTA - FAST homology search All sequences
3. EMBOSS - European Molecular Biology Open Software Suite
4. Clustalw
5. RasMol
6. PROSPECT - Protein Structure Prediction and Evaluation Computer Tool Kit
7. Pattern Hunter

8. COPLA- Consensus Pattern Identification and Analysis

Q.51. Give the applications of Bioinformatics?

Ans. Bioinformatics is being used in following fields:

- Molecular medicine
- Personalized medicine
- Preventative medicine
- Gene therapy
- Drug development
- Microbial genome applications
- Waste cleanup
- Climate change Studies
- Alternative energy sources
- Biotechnology
- Antibiotic resistance
- Forensic analysis of microbes
- Bio-weapon creation
- Evolutionary studies
- Crop improvement
- Insect resistance
- Improve nutritional quality
- Development of Drought resistance varieties.
- Vetinary Science

Q.52. Write a short note on Human Genome Project?

Ans. In 1988, the Human Genome organization (HUGO) was founded. This is an international organization of scientists involved in Human Genome Project. In 1989, the first complete genome map was published of the bacteria Haemophilus influenza. By 1991, a total of 1879 human genes had been mapped. In 1993, Genethon, a human genome research center in France

Produced a physical map of the human genome. Three years later, Genethon published the final version of the Human Genetic Map. This concluded the end of the first phase of the Human Genome Project.

Q.53. What is BLAST?

Ans. BLAST (Basic Local Alignment Search Tool) comes under the category of homology and similarity tools. It is a set of search programs designed for the Windows platform and is used to perform fast similarity searches regardless of whether the query is for protein or DNA. Comparison of nucleotide sequences in a database can be performed. Also a protein database can be searched to find a match against the queried protein sequence. NCBI has also introduced the new queuing system to BLAST (Q BLAST) that allows users to retrieve results at their convenience and format their results multiple times with different formatting options.

Depending on the type of sequences to compare, there are different programs:

- blastp compares an amino acid query sequence against a protein sequence database
- blastn compares a nucleotide query sequence against a nucleotide sequence database
- blastx compares a nucleotide query sequence translated in all reading frames against a protein sequence database
- tblastn compares a protein query sequence against a nucleotide sequence database dynamically translated in all reading frames.
- tblastx compares the six-frame translations of a nucleotide query sequence against the six-frame translations of a nucleotide sequence database.

Q.54. Explain FASTA?

Ans. **FAST** homology search All sequences An alignment program for protein sequences created by Pearsin and Lipman in 1988. The program is one of the many heuristic algorithms proposed to speed up sequence comparison. The basic idea is to add a fast prescreen step to locate the highly matching segments between two sequences, and then extend these matching segments to local alignments using more rigorous algorithms such as Smith-Waterman.

Q.55. Give the applications of JAVA and Perl in Bioinformatics?

Ans. The Applications of Programs in Bioinformatics are:

1. JAVA in Bioinformatics: Since research centers are scattered all around the globe ranging from private to academic settings, and a range of hardware and OSs are being used, Java is emerging as a key player inbioinformatics. Physiome Sciences' computer-based biological simulation technologies and Bioinformatics Solutions' PatternHunter are two examples of the growing adoption of Java in bioinformatics.

2. Perl in Bioinformatics: String manipulation, regular expression matching, file parsing, data format interconversion etc are the common text-processing tasks performed in bioinformatics. Perl excels in such tasks and is being used by many developers. Yet, there are no standard modules designed in Perl specifically for the field of bioinformatics. However, developers have designed several of their own individual modules for the purpose, which have become quite popular and are coordinated by the BioPerl project.

Q.56. In short write about different Bioinformatics projects?

Ans. The various Bioinformatics projects are:

1. BioJava: The BioJava Project is dedicated to providing Java tools for processing biological data which includes objects for manipulating sequences, dynamic programming, file parsers, simple statistical routines, etc.

2. BioPerl: The BioPerl project is an international association of developers of Perl tools for bioinformatics and provides an online resource for modules, scripts and web links for developers of Perl-based software.

3. BioXML: A part of the BioPerl project, this is a resource to gather XML documentation, DTDs and XML aware tools for biology in one location.

4. Biocorba: Interface objects have facilitated interoperability between bioperl and other perl packages such as Ensembl and the Annotation Workbench. However, interoperability between bioperl and packages written in other languages requires additional support software. CORBA is one such framework for interlanguage support, and the biocorba project is currently implementing a CORBA interface for bioperl. With biocorba, objects written within bioperl will be able to communicate with objects written in biopython and biojava.

5. Ensembl: Ensembl is an ambitious automated-genome-annotation project at EBI. Much of Ensembl\'s code is based on bioperl, and Ensembl developers, in turn, have contributed significant pieces of code to bioperl. In particular, the bioperl code for automated sequence annotation has been largely contributed by Ensembl developers

6. bioperl-db: Bioperl-db is a relatively new project intended to transfer some of Ensembl's capability of integrating bioperl syntax with a standalone Mysql database to the bioperl code-base. It is worth mentioning that most of the bioperl objects mentioned above map directly to tables in the bioperl-db scheme.

7. Biopython and biojava: Biopython and biojava are open source projects with very similar goals to bioperl. However their code is implemented in python and java, respectively. With the development of interface objects and biocorba, it is possible to write java or python objects which can be accessed by a bioperl script, or to call bioperl objects from java or python code. Since biopython and biojava are more recent projects than bioperl, most effort to date has been to port bioperl functionality to biopython and biojava rather than the other way around.

Q.57. Write a short note on Role of Bioinformatics in Biotechnology?

Ans. The term 'bioinformatics' is the short form of `biological informatics', just as biotechnology is the short form of `biological technology'. Anthony Kerlavage, of the Celera Genomics, defined bioinformatics as `Any application of computation to the field of biology, including data management, algorithm development, and data mining'. Clearly, a number of divergent areas, many of them outside biotechnology, come under bioinformatics. Bioinformatics is the field of science in which biology, computer science, and information technology merge to form a single discipline. The ultimate goal of the field is to enable the discovery of new biological insights as well as to create a global perspective from which unifying principles in biology can be discerned. Initial interest in Bioinformatics was propelled by the necessity to create databases of biological sequences. The first database was created within a short period after the Insulin protein sequence was made available in 1956. The sequence information generated by the human genome research, initiated in 1988 has now been stored as a primary information source for future applications in medicine. The available data is so huge that if compiled in books, the data would run into 200 volumes of 1000 pages each and reading alone would require 26 years working around the clock. For the population of about 5 billion human beings with two individuals differing in three million bases, the genomic sequence difference database would have about 15,000,000 billion entries. The present challenge to handle such a huge volume of data is to improve database design, develop software for database access and manipulation, and device data-entry procedures to compensate for the varied computer procedures and systems used in different laboratories. A single

experiment can now yield data on the transcription level of 100,000 different mRNA species from a given tissue.

Q.58. Explain the role of Bioinformatics in Genomics?

Ans. Estimating the number of genes in an organism basing on the number of nucleotide base pairs was not reliable, due to the presence of high numbers of redundant copies of many genes. Genomics has corrected this situation. Useful genes can be selected from a gene library thus constructed and inserted into other organisms for improvement or harmful genes can be silenced. In the areas of structural genomics, functional genomics and nutritional genomics, bioinformatics plays a vital role.

Q.59. How Bioinformatics can be used in studying Proteomics?

Ans. Proteomics involves the sequencing of amino acids in a protein, determining its three dimensional structure and relating it to the function of the protein. Before computer processing comes into the picture, extensive data, particularly through crystallography and NMR, are required for this kind of a study. With such data on known proteins, the structure and its relationship to function of newly discovered proteins can be understood in a very short time. In such areas, bioinformatics has an enormous analytical and predictive potential. Protein folding alone of the most significant and fundamental problem in biologicalscience realizing this, IBM in Dec 1999, had built a supercomputer, which is 2 million times faster than the today's fastest desktop PC. This new computer nicknamed "Blue Gene" by IBM researchers will be capable of performing more than one quadrillion operations per second. Better understanding of how proteins fold will give scientists and doctors better insight into diseases and ways to combat them.

Q.60. Explain the role of Bioinformatics in Drug Design and Modification?

Ans. The role of Bioinformatics is:

1. Cheminformatics and Drug Design: It is now possible, through computer algorithm based bioinformatics procedures, to identify and structurally modify a natural product, to design a drug with the desired properties and to assess its therapeutic effects, theoretically. Such procedures, similar to an architect's on board plan before construction, are described as *in silico* (in the computer, based on silicon chip technology), as opposed to the earlier *in vitro* (in experimental models) and *in vivo* (in clinical trials) methods. The risk involved in the earlier random processes of drug discovery methods is largely

removed
by bioinformatics. Cheminformatics involves organization of chemical data in a logical form to facilitate the process of understanding chemical properties, their relationship to structures and making inferences.

2. Drug Modification: Several synthetic products are quite useful but cannot be used by one and all for certain side effects in some people. For example, aspartame (marketed under different trade names) is a dipeptide of aspartic acid and phenylalanine, and is 300 times sweeter than cane sugar. Aspartame is widely used as an alternate sweetener by diabetics and others who cannot take sweeteners loaded with calories. Unfortunately, pregnant women and people suffering from phenylketonuria, a disorder due to an impaired metabolism of phenylalanine, should not use aspartame. It would be useful if phenylalanine were substituted by some other amino acid without affecting its sweetness, to remove the restriction on its use. **Q.61.Give the application of Bioinformatics in Molecular Phylogeny ?**

Ans. Phylogeny is the origin and evolution of organisms. Biologists have constructed very elegant systems of classifications for the known organisms, though problems persist. Extensive work was carried out this way, comparing a very large number of organisms of plants and animals. Amino acid sequences and characteristics of proteins are also used in systematics.

Q.62. Name few Nucleotide Sequence Databases?

Ans. Some Nucleotide Sequence Databases are:

1. GenBank	2. Entrez
3. UniGene	4. Transterm
5. VectorDB	6. UniVec
7. ASD	8. SpliceDB
9. DPInteract	10. HemoPDB
11. PlantCARE	12. 5s rRNA Database
13. PolyA DB	14. NCBI Protein Database
15. UniPort	16. UniRef

****

Multiple Choice Questions

1. The first bioinformatics database was created by
   a. Richard Durbin
   b. Dayhoff
   c. Michael j.Dunn
   d. Pearson

2. SWISSPROT protein sequence database began in
   a. 1985
   b. 1986
   c. 1987
   d. 1988

3. An example of Homology & similarity tool?
   a. PROSPECT
   b. EMBOSS
   c. RASMOL
   d. BLAST

4. The tool for identification of motifs?
   a. COPIA
   b. Patternhunter
   c. PROSPECT
   d. BLAST

5. First molecular biology server Expasy in the year?
   a. 1991
   b. 1992
   c. 1993
   d. 1994

6. Deposition of cDNA into inert structure is
   a. DNA finingerprinting
   b. DNA polymerase
   c. DNA probes
   d. DNA microarrays

7. Human genome contains about
   a. 2 billion base pairs
   b. 3 billion base pairs
   c. 4 billion base pairs

d. 5 billion base pairs

8. The identification of drugs through genomic study
   a. Genomics
   b. Cheminformatics
   c. Pharmagenomics
   d. Phrmacogenetics

9. Analysing or comparing entire genome of species
   a. Bioinformatics
   b. Genomics
   c. Proteomics
   d. Pharmacogenomics

10. Characterizing molecular component is
   a. Genomics
   b. Cheminformatics
   c. Proteomics
   d. Bioinformatics

11. "There is a plenty of room at the bottom." This was stated by
   a. Issac Newton
   b. Albert Einstein
   c. Richard Feynman
   d. Eric Drexler

12. 1 nanometre= _____ cm.
   a. $10^{(-9)}$
   b. $10^{(-8)}$
   c. $10^{(-7)}$
   d. $10^{(-6)}$

13. The size of E.coli bacteria is _____ nm
   a. 75000
   b. 2000
   c. 200
   d. 5

14. The diameter of human hair is _____ m
    a. 75000
    b. 75
    c. $7.5 \times 10^{(-5)}$
    d. $7.5 \times 10^{(-9)}$

15. The most important property of nanomaterials is
    a. force
    b. friction
    c. pressure
    d. temperature

16. The diameter of a bucky ball is about _____
    a. 1 A^o
    b. 100 A^o
    c. 1 nm
    d. 10 nm

17. A bucky ball is a molecule consisting of ___ carbon atoms
    a. 50
    b. 60
    c. 75
    d. 100

18. The cut-off limit of human eye to see is _____ nm
    a. 10
    b. 100
    c. 1000
    d. 10000

19. 1 meter = _____ nm.
    a. 10^9
    b. $10^{(-9)}$
    c. 10^{10}
    d. $10^{(-10)}$

20. The diameter of a bucky ball is about _____

a. 1 A^o
b. 10 A^o
c. 100 A^o
d. 1000 A^o

21. The diameter of hydrogen atom is _____ nm.
a. 10
b. 1
c. 0.1
d. 0.01

22. The size of a quantum dot is _____ m.
a. 5
b. $5 \times 10^{(-9)}$
c. $5 \times 10^{(-10)}$
d. $5 \times 10^{(-11)}$

23. 20 micron = _____ nm
a. $20 \times 10^{(-9)}$
b. 20×10^{9}
c. 200
d. 20000

24. 1 mm = _____ nm
a. 10^6
b. $10^{(-6)}$
c. 10^7
d. $10^{(-7)}$

25. The hardest material found in nature is _____.
a. steel
b. topaz
c. diamond
d. quartz

26. _____ are the extentions of bucky balls.
a. Geodesic domes

b. Hexagons
c. Carbon nanotubes
d. AFM and STM

27. Nanotechnology, in other words, is
a. Carbon engineering
b. Atomic engineering
c. Small technology
d. Microphysics

28. The width of carbon nanotube is _____nm.
a. 1
b. 1.3
c. 1.55
d. 10

29. The diameter of fly ash particles is _____ µm
a. 5-10
b. 10-20
c. 20-30
d. 100

30. The tensile strength of a carbon nanotube is _____ times that of steel.
a. 10
b. 25
c. 100
d. 1000

31. The ratio of thermal conductivity of silver to that of a carbon nanotube is _____.
a. 100 : 1
b. 1 : 100
c. 10 : 1
d. 1 : 10

32. In a bucky ball, each carbon atom is bound to _____ adjacent carbon atoms.
a. 1
b. 2

c. 3
d. 4

33. The size of red and white blood cells is in the range of _____µm.
a. 2-5
b. 5-7
c. 7-10
d. 10-15

1. Who coined the word "Nanotechnology"?

Ans: K. Eric Drexler coined the word "Nanotechnology".

2. Who wrote the book "Engines of Creation"?

Ans: K. Eric Drexler wrote the book "Engines of Creation".

3. What is the meaning of the Greek word "Nano"?

Ans: "Nano" means "dwarf".

4. What is the meaning of "Technology"?

Ans:"Technology" is a process of using scientific principles and techniques to design new materials, devices, and systems for prosperity, comforts, betterment and enhancement of human life.

5. What is Atomic Engineering?

Ans: Atomic Engineering is the science involving manufacture of products with different properties by rearrangement of atoms.

6. Define: Nanotechnology.

Ans: Nanotechnology is atom-by-atom or molecule-by-molecule building of structures that will be helpful in manufacturing new devices and systems.

7. How much is 1 micron in meter ?

Ans: 1 micron is equal to 10^{-6} meter.

8. What is the size of an integrated circuit transistor?

Ans: The size of an integrated circuit transistor is 90 nm.

9. What is the size of a virus?

Ans:A virus is 50 nm in size.

10. Mention the width of a DNA molecule.

Ans:A DNA molecule has width of about 2 nm.

11. What is the diameter of the hydrogen atom?

Ans:The diameter of the hydrogen atom is 0.1 nm.

12. What is the full form of MEMS?

Ans:"MicroElectro Mechanical Systems" is the full form of MEMS

13. What is the size of red blood cells?

Ans:The size of red blood cells is 5000 nm.

14. What is the size of a quantum dot?

Ans:The size of a quantum dot is 5 nm.

15. Who invented STM(Scanning Tunneling Microscope)?

Ans:Gern Binnig and Heinrich Rohre of IBM Research Lab invented STM in 1981.

16. What can be considered as a loose atom or molecule floating in space?

Ans:Anything smaller than a nanometer can be considered as a loose atom or molecule floating in space.

17. What made it possible to study atoms and their manipulation in developing new structures ?

Ans:The invention of Scanning Tunneling Microscope(STM) made it possible to study atoms and their manipulation in developing new structures.

18. What is the full form of AFM?

Ans:The full form of AFM is Atomic Force Microscope.

19. Which two types of fundamental molecules find wide applications in nanotechnology?

Ans:Bucky balls and carbon nanotubes are two types of fundamental molecules that find wide applications in nanotechnology.

20. Why does nanotechnology play by different rules ?

Ans:Nanotechnology plays by different rules because of larger surface area relative to the volume of nanomaterials.

21. Who discovered Buckminsterfullerene(bucky ball)?

Ans:Robert F. Curl,Jr.; Harold W. Croto; and Richard E. Smalley discovered the buckminsterfullerene in 1985.

22. What does a bucky ball comprise of?

Ans:A bucky ball comprises of 60 carbon atoms in the architectural configuration of a soccer ball(sphere).

23. Who designed the famous geodesic dome?

Ans:American architect Buckminster Fuller designed the famous geodesic dome.

24. What are carbon nanotubes? OR What are fullerenes?

Ans:Carbon nanotubes are long tubular structures formed by joining bucky balls without their ends closing so that spheres are not formed.

25. Who conceptualised carbon nanotubes?

Ans:Richard Smalley conceptualised carbon nanotubes.

26. What is a bucky tube?

Ans:A bucky tube is a carbon nanotube derived from bucky balls.

27. Mention the types of carbon nanotubes.

Ans:The types of carbon nanotubes are:(1) Single Walled Nano Tube (SWNT)and (2)Multi Walled Nano Tube (MWNT)

28. List out the areas of nanoscience.

Ans:The areas of nanoscience are:(1)nanotubes (2)nanofabrication (3)nanomaterials (4)nanocomposites

29. Who photographed nanotubes for the first time ?

Ans:Sumio Tijima of NEC Laboratory photographed nanotubes for the first time.

30. Why do carbon nanotubes have very high tensile strength ?

Ans:Carbon nanotubes have very high tensile strength due to carbon-carbon bonds and the fact that each carbon tube is a very large molecule.

31. How do carbon nanotubes conduct heat ? OR Why do carbon nanotubes have high thermal conductivity ?

Ans:Carbon nanotubes have high thermal conductivity because they conduct heat by vibrations of covalent bonds between carbon atoms.

32. How is nanotechnology useful in destroying tumours of cancer ?

Ans:A nanoshell of 100nm diameter floating through the body will be able to get attached only to cancerous cells which upon excitation by a laser beam will dissipate heat and destroy the tumour.

33. How can the melting point of materials be tuned using nanotechnology ?

Ans:The melting point of materials can be tuned by controlling their particle size in the range of nanoscale.

34. How can collateral damage be minimized during explosion using nanotechnology ?

Ans: The collateral damage during explosion can be minimized by varying the size of nanoparticles in munitions.

35. What is the use of nanocrystals ?

Ans:Nanocrystals can be used to transform electricity into light without excessive loss of energy due to heating.

36. Which fields of science will be affected by the progress of nanotechnology ?

Ans:The fields like nanotubes, nanofabrication, nanomaterials and nanocomposites will be affected by the progress of nanotechnology.

37. Mention two phenomena which are dominant and important at nanoscales(as compared to larger dimensions).

Ans:Sticking and friction are dominant and important at nanoscales.

38. How can the mapping of DNA of a newly born baby be useful ?

Ans:The mapping of DNA of a newly born baby can help obtain information about future potential problems, enabling to curtail diseases at an early stage.

39. Mention the range of wavelength of visible light in nanometer.

Ans: The range of wavelength of visible light is 400 to 700 nm.

40. Who outlined the "Vision and Prospects of Atomic Engineering'?

Ans: Richard Feynman.

41. What is the diameter of human hair?

Ans: The diameter of human hair is 75000 nm.

42. What is the full form of GPS?

Ans: The full form of GPS is Global Positioning System.

43. What is the size of MEMS?

Ans: The size of MEMS is 10^{-6} to 10^{-4} m.

44. What is the size of a nanoshell?

Ans: The size of a nanoshell is 100 nm.

Key Terms

Adsorption is a process that occurs when a gas or liquid solute accumulates on the surface of a solid or, more rarely, a liquid (adsorbent), forming a molecular or atomic film (the adsorbate). It is different from absorption, in which a substance diffuses into a liquid or solid to form a solution. The term sorption encompasses both processes, while desorption is the reverse process.

Alpha helix - one of two types of protein secondary structure. An alpha helix is a tight helix that results from the hydrogen bonding of the carboxyl (CO) group of one amino acid to the amino (NH) group of another amino acid.

Anion consists of one or more atoms and carries a unit charge of electricity. Those that are negative ions (hydroxyl and acidic atoms or groups) are called anions.

Assembler: A general-purpose device for molecular manufacturing, capable of guiding chemical reactions by positioning molecules.

Atom: The smallest unit of a chemical element, about a third of a nanometer in diameter. Atoms make up molecules and solid objects.

Brownian Motion: Motion of a particle in a fluid owing to thermal agitation.

Catalyst: A substance that increases the rate of a chemical reaction by reducing the activation energy, but which is left unchanged by the reaction. A catalyst works by providing a convenient surface for the reaction to occur. The reacting particles gather on the catalyst surface and either collide more frequently with each other or more of the collisions result in a reaction between particles because the catalyst can lower the activation energy for the reaction.

cDNA or complementary DNA - DNA that is synthesized in the laboratory from a messenger RNA template

CDS - The coding sequence or the portion of a nucleotide sequence that makes up the triplet codons that actually code for amino acids.

Chemical Vapour Deposition (CVD): A technique used to deposit coatings, where chemicals are first vaporized, and then applied using an inert carrier gas such as nitrogen.

Contig - Group of cloned (copied) pieces of DNA representing overlapping regions of a particular chromosome

CRT: Cathode Ray Tube.

DNA Chip: A purpose built microchip used to identify mutations or alterations in a gene's DNA.

Domain - a discrete portion of a protein assumed to fold independently of the rest of the protein and possessing its own function.

ESM: Electro Scanning Microscope

Expressed sequence tag or EST - A short strand of DNA that is a part of a cDNA molecule and can act as identifier of a gene. Used in locating and mapping genes.

Gene locus (pl. loci) - Gene's position on a chromosome or other chromosome marker; also, the DNA at that position. The use of locus is sometimes restricted to mean expressed DNA regions.

Gene Ontology - A controlled vocabulary of terms relating to molecular function, biological process, or cellular components developed by the Gene Ontology Consortium. A controlled vocabulary allows scientists to use consistent terminology when describing the roles of genes and proteins in cells.

GI (GenBank) - A GI or "GenInfo Identifier" is a sequence identifier that can be assigned to a nucleotide sequence or protein translation. Each GI is a numeric value of one or more digits.

GI (GenBank) - A GI or "GenInfo Identifier" is a sequence identifier that can be assigned to a nucleotide sequence or protein translation. Each GI is a numeric value of one or more digits.

Global alignment - when two nucleic acid or amino acid sequences are lined up along their entire length. See also local alignment

Homology - similarity in sequence that is based on descent from a common ancestor

Identity - the extent to which two sequences are invariant

Ligand - A small molecule noncovalently bonded to a larger macromolecule.

Ligand: An ion, a molecule, or a molecular group that binds to another chemical entity to form a larger complex.

Local alignment - the alignment of portions (rather than the entire sequence length) of two nucleic acid or amino acid sequences

Masking - the removal of repeated or low complexity regions from a sequence so that sequences are compared

MEMS: MicroElectroMechanical Systems

Moiety: In organic chemistry, functional groups (or moieties) are specific groups of atoms within molecules, that are responsible for the characteristic chemical reactions of those molecules.

Molecular Wire: A quasi-one-dimensional molecule that can transport charge carriers (electrons or holes) between its ends.

Motif - A discrete portion of a protein assumed to fold independently of the rest of the protein and possessing its own function. Some common types of motifs are made up of two or more alpha helices or beta sheets.

Motility: A biological term which refers to the ability to move spontaneously and independently. It can apply to either single-celled or multicellular organisms.

Nano: A prefix meaning one billionth (1/1 000 000 000).

Nanoarray: An ultra-sensitive, ultra-miniaturized array for biomolecular analysis.

Nanobiotechnology: Applies the tools and processes of nano/microfabrication to build devices for studying biosystems.

Nanocrystal: Molecular-sized solids formed with a repeating, 3D pattern of atoms or molecules with an equal distance between each part. Nanocrystals are aggregates of anywhere from a few hundred to tens of thousands of atoms that combine into a crystalline form of matter known as a 'cluster'.

Nanoelectronics: Electronics on a nanometre scale, whether made by current techniques or nanotechnology; includes both molecular electronics and nanoscale devices resembling today's semiconductor devices.

Nanofabrication: Design and manufacture of devices with dimensions measured in nanometres.

Nanofluidics: Controlling nanoscale amounts of fluids.

Nanohorns: One of the SWNT (single walled carbon nanotube) types, with an irregular horn-like shape.

Nanometre: One billionth of a metre. 10-9m, or a millionth of a millimetre.

Nano-optics: Interaction of light and matter on the nanoscale.

Nanopores: Nanoscopic pores found in purpose-built filters, sensors, or diffraction gratings.

Nanoscale: Between 0.1-100nm.

Nanotube: A one-dimensional fullerene (a convex cage of atoms with only hexagonal and/or pentagonal faces) with a cylindrical shape.

Nanowires: One-dimensional structures, with unique electrical and optical properties, that are used as building blocks in nanoscale devices.

NMR: Nuclear Magnetic Resonance

NMR: Nuclear Magnetic Resonance

Orthologous - homologous sequences in different species that result from a common ancestral gene during speciation. Orthologous genes may or may not have similar functions.

Paralogous - homologous sequences within a single species that are the result of gene duplication

Primary structure -the amino acid sequence of a polypeptide chain. Of the four levels of protein structure, this is the most basic.

Quaternary structure - the interconnection and arrangement of polypeptide chains within a protein. Only proteins with more than one polypeptide chain can have quaternary structure.

Query - the input sequence (in FASTA format or as bare sequence data) or sequence identifier with which all the sequences in a database are compared during a BLAST search

Secondary structure - the folded, coiled, or twisted shape of a polypeptide that results from hydrogen bonding between parts of a molecule. There are two types of secondary structure: alpha helix and a beta pleated sheet

Similarity - how related one nucleotide or protein sequence is to another. The extent of similarity between two sequences is based on the percent of sequence identity and/or conservation.

Tertiary structure - the three-dimensional structure of a polypeptide chain that results from the way that the alpha helices and beta pleated sheets are folded and arranged

M.Sc./B.Sc. (Part III) Examination, 2011

(FACULTY OF SCIENCE)

(Common to Three and Five Year Integrated Course)

BIOTECHNOLOGY

PAPER BT-802

FUNDAMENTALS OF BIOINFORMATICS AND NANOTECHNOLOGY

Time.: 3 Hours *Max.M.:50*

Attempt FIVE questions in all, including Questions No. 1 Which is compulsory, selecting ONE question from each Unit. Each question carries equal 10 marks.

1. Explain the following:

(i) PSI-BLAST
(ii) PDB Format
(iii) Orthologous sequences
(iv) Molecular Phylogeny
(v) Moore's Law
(vi) Quantum dots
(vii) Kanzius RF therapy
(viii) Graphene
(ix) Nanosomes
(x) Molecular Viewers 1 X 10 = 10

Unit I

2. What is bioinformatics? Why do people consider it as an interdisciplinary subjects?

or

3. What is a biological database and how can it be classified?

Unit II

4. (a) What is NCBI?
(b) Describe the concept of alignment.

or

5. Explain the different types of nanomaterials

Unit III

6. Describe the main properties of nanomaterials.

or

7. Explain the different microscopic techniques to see nono-objects.

Unit IV

8. Write notes on :
   (a) Nanotechnology and Biosensors
   (b) Nanotechnology in drug delivery

or

9. Write notes on any two of the following:
   (a) Silver Nanoparticles and water purification
   (b) Nanotechnology and future and light sources
   (c) Nanocomputers
   (d) Methods for preparing nanomaterials.

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